

I claim:

- 1 1. An apparatus for generating narrow bandwidth picosecond optical pulses
2 comprising:
3 a pump laser;
4 an optical parametric oscillator pumped by a pump pulse train generated by the
5 pump laser;
6 an optical parametric amplifier having an input coupled to an output of the optical
7 parametric oscillator and pumped by the pump laser,
8 wherein the optical parametric oscillator comprises an optical cavity comprised of
9 a grating-mirror termination on one end of the cavity and a cavity mirror on an opposing
10 end of the cavity with optically nonlinear active media therebetween.
- 1 2. The apparatus of claim 1 where the grating-mirror termination on one end of the
2 cavity is comprised of a grazing incidence grating and a tuning mirror, the grating and
3 mirror being arranged with respect to each other so that a diffracted first order is
4 reflected back from the mirror to the grating and into the cavity.
- 1 3. The apparatus of claim 2 where the grazing incidence grating has a periodicity of
2 about equal to the groove spacing of the grating.

1 4. The apparatus of claim 2 where the cavity has an axis and where the grazing
2 incidence grating is inclined at an approximately 10° angle with respect to the axis.

1 5. The apparatus of claim 2 where the grazing incidence grating has a blaze
2 optimized for grazing incidence to maximize a first grating order of diffraction.

1 6. The apparatus of claim 2 where the cavity has an optical length and where the
2 tuning mirror is rotatable about a center defined about the grating so that the resonant
3 wavelength of the cavity can be adjusted without changing the optical length of the
4 cavity.

1 7. The apparatus of claim 1 where pulses in the optical parametric oscillator are
2 characterized by a bandwidth and where the pump laser introduces a train of pulses into
3 the optical parametric oscillator of sufficient strength to trigger a multiple number of
4 round trips of pulses in the cavity of the optical parametric oscillator in which each
5 reflection of a pulse from the grating-mirror termination narrows the bandwidth of the
6 pulse.

1 8. The apparatus of claim 1 where the cavity of the optical parametric oscillator
2 further comprises a concave mirror or lens to image light transmitted to and received
3 from the grating-mirror termination to increase stability of the cavity.

1 14. The apparatus of claim 13 where each BBO crystal is independently rotatable to
2 adjust an angular orientation of each BBO crystal in the cavity.

1 15. The apparatus of claim 1 where the optical parametric oscillator and optical
2 parametric amplifier in combination generate a pulse having a bandwidth characterized
3 by a Fourier limit with the bandwidth of the generated pulse being near the Fourier limit.

1 16. A method for generating a narrow bandwidth picosecond optical pulse
2 comprising:
3 generating a pump laser pulse train;
4 pumping an optical parametric oscillator by the pump pulse train;
5 generating a pulse train output with a narrowed bandwidth and picosecond pulse
6 width from the optical parametric oscillator by use of a grating-mirror termination on one
7 end of a cavity in the optical parametric oscillator and a cavity mirror on an opposing
8 end of the cavity with optically nonlinear active media therebetween;
9 pumping an optical parametric amplifier having an input coupled to an output of
10 the optical parametric oscillator; and
11 outputting the narrow bandwidth picosecond optical pulse from the optical
12 parametric amplifier.

1 17. The method of claim 16 where the grating-mirror termination on one end of the
2 cavity is comprised of a grazing incidence grating and a tuning mirror, and where
3 generating a pulse train output with a narrowed bandwidth and picosecond pulse width

4 generates a diffracted first order reflected back from the mirror to the grating and into
5 the cavity.

1 18. The method of claim 17 further comprising providing the grazing incidence
2 grating with a periodicity such that the center wavelength is about a groove spacing.

1 19. The method of claim 17 where the cavity has an axis and further comprising
2 providing the grazing incidence grating with an inclination of an approximately 10° angle
3 with respect to the axis.

1 20. The method of claim 17 further comprising providing the grazing incidence
2 grating with a blaze optimized for grazing incidence to maximize a first grating order of
3 diffraction.

1 21. The method of claim 17 where the cavity has an optical length and further
2 comprising rotating the tuning mirror about a center defined about the grating so that
3 wavelength of the cavity can be adjusted without changing the optical length of the
4 cavity.

1 22. The method of claim 16 where pumping an optical parametric oscillator
2 comprises pumping the optical parametric oscillator with pulses characterized by a
3 bandwidth and sufficient strength to trigger a multiple number of round trips of pulses in

4 the cavity of the optical parametric oscillator in which each reflection of a pulse from the
5 grating-mirror termination narrows the bandwidth of the pulse.

1 23. The method of claim 16 further comprising stabilizing the cavity of the optical
2 parametric oscillator by providing a concave mirror or lens in the cavity to image light
3 transmitted to and received from the grating-mirror termination to increase stability of
4 the cavity.

10 24. The method of claim 23 where the light in the cavity is characterized by a
11 wavefront and where stabilizing the cavity of the optical parametric oscillator comprises
12 flattening the wavefront of the light at the grating-mirror termination relative to the
13 wavefront at the center of the cavity.

14 25. The method of claim 16 where generating a pulse train output with a narrowed
15 bandwidth and picosecond pulse width couples a 0th order diffraction of light from the
16 cavity of the optical parametric oscillator into the optical parametric amplifier.

1 26. The method of claim 16 where outputting the narrow bandwidth picosecond
2 optical pulse inputs a single pulse from the pump laser pulse train into the optical
3 parametric amplifier to coincide with the last pulse of a pulse train output by the optical
4 parametric oscillator and coupled into the input of the optical parametric amplifier.

1 27. The method of claim 16 where generating a pulse train output from the optical
2 parametric oscillator comprises generating the pulse train in at least one BBO crystal.

1 28. The method of claim 27 where generating a pulse train output from the optical
2 parametric oscillator comprises generating the pulse train in a pair of BBO crystals
3 arranged with respect to each in a walk-off compensating arrangement to extend power
4 capability of the optical parametric oscillator.

1 29. The method of claim 28 further comprising independently rotating each BBO
2 crystal to adjust an angular orientation of each BBO crystal in the cavity.

1 30. The method of claim 16 where outputting the narrow bandwidth picosecond
2 optical pulse from the optical parametric amplifier comprises generating a pulse having
3 a bandwidth characterized by a Fourier limit with the bandwidth of the generated pulse
4 being near the Fourier limit.